Application

for

United States Patent

To all whom it may concern:

Be it known that we, Gilles Boccon-Gibod and David Bryan have invented certain new and useful improvements in

PERSONAL VIDEO RECORDERS WITH AUTOMATED BUFFERING

of which the following is a full, clear and exact description:

PERSONAL VIDEO RECORDERS WITH AUTOMATED BUFFERING

RELATED APPLICATIONS

This application is related to the following United States Patent Applications,

incorporated by reference herein:

PERSONAL VIDEO RECORDER COMMUNITIES, filed _____, Serial No._____; and

METHOD AND APPARATUS FOR EXCHANGING PREFERENCES FOR REPLAYING A PROGRAM ON AN PERSONAL VIDEO RECORDER filed _____, serial No. _____.

BACKGROUND OF THE INVENTION

[0001] Field of Invention

[0002] This invention pertains to a method and apparatus for buffering portions of a broadcast program. More specifically, the invention pertains to a method and apparatus that continuously monitors one or more program sources, determines whether any of the programs are of interest to a user and in response buffers a portion of the program to allow the user to view the program from the beginning.

[0003] Description of the Prior Art

[0004] Because of their flexibility, advanced capabilities, and ease-of-use, digital technology-based consumer products such as Personal Video Recorders (PVRs) have begun to provide an alternative to VCRs as the primary means for recording television programs in the home. PVRs have a number of technical advantages over

VCRs and other analog recording technologies, stemming primarily, from the fact that they use digital data storage devices such as hard drives and optical discs. These types of data storage devices provide significantly more storage capacity because of high storage density and the use of digital compression techniques. They also provide fast and random access to their content and the ability to manage this content very easily. Finally, digital random access allows for the simultaneous reading and writing of two or more data streams.

[0005] PVRs typically use powerful microprocessors to control the digital storage and other functionality. These processors generally provide more processing power than the controllers used in VCRs and are capable of supporting sophisticated processing.

[0006] PVRs and similar devices allow consumers to spend more time watching television or video programming that they like, and less time sorting through or watching television or programming they don't like. With a PVR, a consumer can find a program or series of programs of interest from an on-screen program guide, and direct the system to record an individual program or all of the programs pertaining to particular subject matter, interests, or meeting some other criteria.

[0007] PVRs have many other advantages as well. A PVR can be programmed to skip reruns or adjust for broadcast schedule changes. For example, the TiVo "Season Pass" recording service allows a user to record a series during a whole season. A PVR user can also find and record television programs by title, sports team, actor, director and word.

[0008] Some PVRs also allow the user to rate programs, and, based on the programs the user indicates are of interest, will "learn" what types of programs the user likes and will record those types of programs (in their entirety) automatically. The user can subsequently locate the list of stored programs from a menu or catalog and retrieve an individual title for viewing. This allows the user to simply locate and view the recording and avoids the use of bulky storage tapes that need to be manually inserted and which take up significant storage space.

[0009] A feature that significantly differentiates a PVR from the traditional Video Cassette Recorder (VCR) is the PVR's ability to simultaneously record a program while playing back the same or different program. This feature allows a user to pause a current program (even if it is 'live'), and then, some time later, continue watching the program from the instant that the program was paused while the remainder of the program is being recorded (if required). This mode of operation is termed 'incidental recording'.

[0010] In current PVRs, incidental recording is simply implemented by recording whatever a user is currently watching as defined or determined by the setting of the PVR tuner and/or the tuner of the user's TV set. If the PVR is not set for incidental recording, it records only scheduled programs. Programs can be scheduled for recording either by the user's explicit instructions or by an automated program selector). While the user is watching a program previously recorded by the PVR, the PVR may also be recording whatever channel was last viewed. Thus, because current PVRs are active only during incidental recording or during scheduled programs, they cannot accommodate a user who wants to watch an unscheduled program in progress from the beginning. For

example, if a user arrives home 5 or 10 minutes late, he/she is not able to watch an unscheduled program from the beginning by "rewinding " the PVR since the PVR is not recording the program. Finally, users who channel surf during commercial breaks or "simultaneously" watch multiple sporting events usually do not have the ability to rewind an unscheduled program to a point before they switched channels.

SUMMARY OF THE INVENTION

[0011] In one embodiment, a method is implemented on a PVR to automatically and intelligently buffer portions of programs, including television programs or other media streams, such as radio broadcasts. The buffering of programs is implemented using predictive selections based on the viewing habits and preferences of a PVR user, recommendation from friends and critics, etc.

[0012] Predictive buffering is an entirely automated process (requiring no user direction or input) and learns directly from the user and external sources without any need for reference to a centralized database. The predictive buffer records programs (or program portions or fragments) based on its internal logic, user behavior, and external recommendations.

[0013] The invention can be implemented in both stand-alone home-use PVRs as well as centralized (head-end) PVRs or local PVRs with distributed or network storage.

[0014] According to this invention, one or more program sources are monitored and if a program is detected that may be of interest to a user, a portion of the program is

buffered for a predetermined period of time, thereby allowing the user to watch the program from the beginning.

[0015] In one embodiment, if a program portion is buffered and the user does not indicate that he/she wants to watch the buffered program, at the end of the program portion, the buffered program portion is discarded and a portion of another program is buffered.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The accompanying drawings, which are incorporated in and form a part of the specification, illustrate the embodiments of the present invention and, together with the description serve to explain the principles of the invention.

[0017] In the drawings:

[0018] FIG. 1 illustrates a typical hookup of a Personal Video Recorder into a home entertainment system;

[0019] FIG. 2 is a simplified functional block diagram of a Personal Video Recorder;

[0020] FIG. 3 is a simplified functional block diagram of an alternate embodiment of a Personal Video Recorder;

[0021] FIG. 4a shows an embodiment of Personal Video Recorder where a plurality of channels may be recorded simultaneously;

[0022] FIG. 4b shows an alternate embodiment of Personal Video Recorder where a plurality of channels may be recorded simultaneously;

[0023] FIG. 5a and FIG. 5b illustrate one possible data structure to track weekly user viewing habits;

[0024] FIG. 6 illustrates a flow chart for an exemplary process used to populate the table of weekly timeslots; and

[0025] FIG. 7 illustrates a flow chart for an exemplary process to use the table of weekly timeslots to perform the predictive buffering function.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS OF THE INVENTION

[0026] In describing the embodiments of the invention illustrated in the drawings, specific terminology will be used for the sake of clarity. However, the invention is not intended to be limited to the specific terms so selected, and it is to be understood that each specific term includes all technical equivalents which operate in a similar manner to accomplish a similar purpose. For example, when we use the term "PVR", we are generally referring to a consumer device with digital storage that is capable of recording television and other multimedia programs. While this includes devices like those sold today by TiVo Inc. and ReplayTV (Digital Networks North America, Inc.), it is also intended to include any stand-alone device with similar functionality, as well as set-top boxes for cable and satellite television that have the same or similar recording capability. Also contemplated in this discussion are personal computers with a television tuner and software that allows the personal computer to operate as a PVR.

[0027] Additionally, when we refer to a "channel", we are including not only the traditional notion of a local broadcast network affiliate or station, but also the digital equivalent and any other distinctly identifiable (numbered, lettered, labeled, etc.) media vehicle, whether over-the-air, on a cable or satellite delivery system, or through any other

private or public network (including the Internet). Likewise, when we refer to a "program" or a "show", we include both the conventional concept of a complete ½ hour to 2 hour television presentation as well as any complete or partial segment of a regular or special broadcast event.

[0028] FIG. 1 illustrates a typical hookup of a Personal Video Recorder into a home entertainment system. In the system illustrated, Personal Video Recorder 100 is connected to one or more program sources. The program sources may include terrestrial broadcast, satellite broadcast, and cable television (CATV). These program sources are received respectively by a Terrestrial Broadcast Antenna 120, a Satellite Broadcast Dish Antenna 122, and a CATV Feed 124. A program source may comprise analog, digital or a combination of analog and digital types of programs. Video Output 108 and Audio Output 109 of Personal Video Recorder 100 are connected to Television 106 for presentation to the user of programs from Personal Video Recorder 100. Audio Output 109 may alternatively or additionally be connected to Audio System 130 for high-fidelity playback on speakers 135.

[0029] FIG. 2 is a simplified functional block diagram of Personal Video Recorder 100A constructed in accordance with this invention. The particular PVR illustrated in FIG. 2 is for use with analog television broadcasts (over-the-air or CATV, for example). The antenna/cable feed 201 is input to Tuner-IF-Demod 200. Tuner-IF-Demod 200 is the combined functionality of tuner, intermediate frequency (IF) processing, and demodulator. (When we refer, in this specification, to a "tuner", we are typically referring to the Tuner-IF-Demod combination.) These functions serve to tune the selected channel, filter and mix the selected channel to baseband, and demodulate the

received signal into video signal 202 and audio signal 203. The channel is selected by the user through an IR (infrared) remote control (not shown) through Infrared Receiver 235 and Controller 240. Controller 240 programs the channel in Tuner-IF-Demod 200 through Control Bus 245.

[0030] Video signal 202 and audio signal 203 are processed by Media Stream Processor 204, which includes Video Encoder 205 and Audio Encoder 207. Video Encoder 205 digitizes (converts from analog form into digital form) and compresses video signal 202. Video Encoder 205 may use one of the many video compression algorithms such as those included in the standards commonly known as MPEG-1, MPEG-2, or MPEG-4, or another algorithm. Audio Encoder 207 digitizes and compresses audio signal 203. Audio Encoder 207 may use one of the many audio compression algorithms such as those included in the standards commonly known as MPEG-1 (including the algorithm commonly called MP3), MPEG-2, or MPEG-4, or another algorithm. Video Encoder 205 and Audio Encoder 207 may also encrypt the media steams to protect them from unauthorized copying. The digitized video and audio signals 208 and 209 are multiplexed in multiplexer 210 and the multiplexed signal 211 is stored in a file on Digital Storage 215 under the control of Controller 240 through Control Bus 245. Digital Storage 215 may be any fixed or removable mass storage device, including a hard disk drive, an optical disk drive, flash memory, etc.

[0031] Playback comprises the retrieval of a desired media file from Digital Storage 215, and demultiplexing the retrieved media in demultiplexer 220. The demultiplexed video and audio streams are decoded by Video Decoder 225 and Audio Decoder 227. Video Decoder 225 and Audio Decoder 227 use the appropriate

decompression algorithms based on those used in Video Encoder 205 and Audio Encoder 207. Video Decoder 225 and Audio Decoder 227 may also decrypt the media streams if they were encrypted during the encoding process. The outputs of Video Decoder 225 and Audio Decoder 227 are converted to a form that is appropriate for display on Television 106 by NTSC/PAL Modulator 230. The output signals 232 of NTSC/PAL Modulator 230 may include an RF modulated composite video and audio signal as well as separate video and audio signals. Separate video signals may include a baseband composite video signal, an S-Video signal, and a component video signal. Audio signals may include line level analog mono or stereo audio and S/PDIF digital audio signals.

[0032] Controller 240 is responsible for managing all of the functions of Personal Video Recorder 100A and is also responsible for managing the files on Digital Storage 215. Included in the management of the files on Digital Storage 215 is the monitoring of free storage space, removal of unused or unneeded files, and prioritization of storage operations. Controller 240 is also responsible for acquiring, formatting and displaying an Electronic Program Guide (EPG) on television 106. Controller 240 may acquire the data required for the EPG from information carried on the broadcast signal or by downloading data through Network Interface 250 (In FIGS. 3, 4a, 4b, this Network Interface 250 has been omitted for the sake of clarity). The EPG displays a listing of current and upcoming programs on all of the available channels. The user navigates the EPG, searches for programs, and selects programs to view or record by using an IR remote control (not shown) through Infrared Receiver 235.

[0033] Referring again to FIG.2, Digital Storage 215 has a read/write bandwidth that is sufficient, at a minimum, to effectively support simultaneous read and write

operations. This allows a user, for example, to watch a previously recorded program while another program is being recorded. It is also known in the art to play back the same show that is currently being recorded. In many current PVRs, when the user is watching a "live" (or current) program through the PVR, he/she is actually watching playback from the storage media delayed by only a fraction of a second as the program is being recorded. In this way, the PVR can facilitate the "pausing" of a live television broadcast. When the user presses the "Pause" button on the remote control, the PVR freezes the playback display but continues to record the program or channel that the user was watching. When the user wishes to continue watching from the pause point, the PVR begins playback of the recorded program from this point while continuing to record the program or channel. The ability to pause live TV is enabled by the incidental (not explicitly instructed) recording of whatever channel the user is currently viewing. This recording is typically stored in a section of Digital Storage 215 set aside (either statically or dynamically) for this incidental recording.

[0034] Playback from Digital Storage 215 may also be prompted by a request from the user. The user makes a playback request through an on-screen catalog of recorded programs.

[0035] Referring again to FIG. 2, User Identification 260 is used, in some embodiments, to identify which user (or users), from a household of users, is (or are) currently watching programs through the PVR. As discussed in more detail below, User Identification 260 is useful in determining the individual preferences of the user watching TV at a particular moment, if more than one individual is using the same TV, and to determine which programs to buffer.

[0036] Those skilled in the art will appreciate that many of the functions illustrated as separate functional blocks in the diagram illustrated in FIG. 2 (as well as the block diagrams illustrated in FIGs. 3, 4A, and 4B) may be implemented using one or more standard or custom integrated circuit devices, or incorporated wholly, or in part, into controller 240 or into another microprocessor, media processor, digital signal processor, or the like. The block diagrams are intended only to illustrate a functional model of the described embodiment for the purpose of clearly describing these embodiments, and are not intended to illustrate the only possible implementation of these embodiments.

[0037] FIG. 3 is a simplified functional block diagram of an alternate embodiment of Personal Video Recorder 100B. The PVR embodiment illustrated in FIG. 3 is for use with digital broadcasts (over-the-air, CATV, or satellite, for example). The antenna, cable, or satellite dish feed 301 is input to Tuner-IF-Demod 300. Tuner-IF-Demod 300 is the combined functionality of tuner, intermediate frequency (IF) processing, and demodulator. These functions serve to tune the selected channel, filter, mix and demodulate the selected channel to baseband – forming digital transport stream 305. As in FIG. 2, the channel is selected by the user through an IR (infrared) remote control (not shown) through Infrared Receiver 335 and Controller 340. Controller 340 programs the channel in Tuner-IF-Demod 300 through Control Bus 345.

[0038] Digital transport stream 305 may include the data streams from a single program or may include streams from multiple programs. A specific program stream 312 is selected from digital transport stream 305 by Transport Decoder 310. Transport Decoder 310 selects the appropriate program stream based on information provided by

Controller 340 over Control Bus 345. Program stream 312 typically consists of at least one media type, but more typically would comprise at least one compressed digital video and one compressed digital audio stream. Program stream 312 is stored in Digital Storage 315 under the control of Controller 340 through Control Bus 345.

[0039] Playback of recorded media in FIG. 3 is identical to the playback process described above referring to FIG. 2, except that Video Decoder 325 and Audio Decoder 327 use algorithms that are appropriate for decoding the digital broadcast streams from the over-the-air, CATV, or satellite system. User Identification 360 is used, in some embodiments, to identify which user (or users), from a household of users, is (or are) currently watching programs through the PVR, as discussed in more detail below.

[0040] Most television receivers and VCRs come equipped with only a single tuner. This tuner is used by a television to tune to the user-selected channel. In a VCR, the tuner is used to tune to the channel to be recorded, or the channel that is being viewed if the user is watching television "through" the VCR. In some modern television receivers, a second tuner is included to tune an alternate channel and display this channel on a small inset picture on the television display. This feature is called Picture-in-Picture (also called "Pix-in-Pix" or simply "PIP"). VCRs have traditionally included only a single tuner, since they have the capacity to record only one program at a time.

[0041] Most PVRs made today also only include only a single tuner, as illustrated in FIG. 2 and FIG. 3, since they usually have the processing power to encode (digitize and compress) a single video and audio signal for recording on the digital storage media. Some PVRs, however, come equipped with two tuners, along with the capacity to record two programs simultaneously.

[0042] FIG. 4a shows another embodiment of Personal Video Recorder 100C. This embodiment is similar to that shown in FIG. 2, except that in this embodiment a plurality of channels may be recorded simultaneously. FIG. 4a shows, as an example, three instances of Tuner-IF-Demod 200 and Media Stream Processor 204, which would allow for three simultaneous channels to be recorded. Any number of instances of Tuner-IF-Demod 200 and Media Stream Processor 204 may be implemented, limited primarily by the bandwidth of Digital Storage 215.

[0043] FIG. 4b shows yet another embodiment of a Personal Video Recorder. This embodiment is similar to that shown in FIG. 3 and FIG. 4a, except that in this embodiment Personal Video Recorder 100D may simultaneously record a plurality of channels from a digital broadcast source. Like FIG. 4a, FIG. 4b shows multiple instances of Tuner-IF-Demod 300. Unlike the analog system of FIG. 4a, the digital system of FIG. 4b typically contains multiple programs streams within each demodulated output stream 305. There may be one or more instances of Tuner-IF-Demod 300 (three are shown in FIG. 4b) and one or more Transport Decoders 310 for each instance of Tuner-IF-Demod 300. In FIG4b, two Transport Decoders (310a and 310b) are shown connected to Tuner-IF-Demod 300a, one Transport Decoder 310c is connected to Tuner-IF-Demod 300b, and one Transport Decoder 310d is connected to Tuner-IF-Demod 300c. This exemplary combination would allow for up to four simultaneous programs to be recorded. Any number of instances of Tuner-IF-Demod 300 and Transport Decoder 310 (with at least one Transport Decoder 310 per Tuner-IF-Demod 300 required) may be implemented, limited primarily by the bandwidth of Digital Storage 315.

[0044] In prior art PVRs, if the user was not watching a current broadcast through the PVR (when the PVR was "Off"), only programs that had been scheduled for recording were typically recorded. If the user was watching a program previously recorded by the PVR, the PVR may also have been recording whatever channel was last being viewed live. In this sense, prior art recording only addressed the ability to pause a live broadcast.

[0045] In the present invention, an idle PVR enters a buffering mode in which the PVR determines if a program available from a single source (for the embodiments of FIGS. 2 and 3) or multiple sources (for the embodiments of FIGS. 4a and 4b) are of interest to one or more users. If such a program is detected, then a portion of the program is buffered.

[0046] More specifically, referring to FIG. 2, while the PVR 100A is idle, the controller 240 monitors the programs available to tuner 200. If a program is identified that is likely to be of interest to the user, then the multiplexed signal 211 is stored in Buffer 252. Buffer 252 is large enough so that it can store a predetermined portion of the program, for example the first 15-30 minutes. (Buffer 252 is shown as a separate element, although it could be implemented as part of storage 215.)

[0047] Predictive buffering pertains to a process of recording one or more programs or program fragments in anticipation of a viewer being interested in watching a program on a PVR or switching PVR channels. One objective of predictive buffering is to allow a user to begin watching a program from the beginning, despite switching on the television sometime after the start of the program. A second objective of predictive

buffering is to allow a user to channel surf or watch several programs "simultaneously" with the ability to rewind to portions missed while watching another channel or program.

[0048] In one embodiment, predictive buffering comprises the steps of:

[0049] - observing, learning or discovering user habits, schedules and other patterns of viewership,

[0050] - processing this data to determine television programs that have an elevated likelihood of being watched by the viewer, and

[0051] - automatically buffering these programs in anticipation of a user wanting to watch them.

[0052] The extent to which predictive buffers may be used is a function of the capabilities of a PVR or PVR-like device. Since predictive buffers use idle PVR record capacity, predictive buffering capability is a function of the number of tuners (and transport decoders in PVRs for digital broadcast), the media stream processing capacity, and the read/write bandwidth of the digital storage device. As discussed above, in a PVR that has only a single tuner (FIG. 2 or FIG. 3, for example), predictive buffering can only be done on a single channel in either buffer 252 or 352 and only while the user is not watching television through the PVR and the PVR is not making a prescheduled recording. Note that if the user is watching a previously recorded program from the PVR and the PVR is not recording a prescheduled program, the tuner is available for use by the predictive buffering process.

[0053] Additional tuners and transport decoders within a PVR (see FIG. 4a and FIG. 4b) enhance the capability to perform predictive buffering by providing more opportunities to make use of otherwise idle recording capacity. It also enhances the

predictive buffering capability by allowing for the simultaneous buffering of several programs on multiple channels. Predictive buffering of multiple channels simultaneously would be useful, for example, with sports fans who channel surf between or among multiple sporting events. Predictive buffering would track channel change activity and buffer, in addition to the channel being watched, the alternate channel or channels (depending on the capability of the PVR). In this way, the sports enthusiast would be able to rewind back to a missed goal or touchdown, even though they were not watching the channel at the time of the missed event. The controller either automatically determines which channels are being watched "simultaneously" or requests that the user enter a list of channels to be buffered.

[0054] In another embodiment, a variant on the above predictive buffering strategy is employed. In this embodiment, the last N channels watched are buffered, where N is the number of tuners (and transport decoders in PVRs for digital broadcast) available to the buffering process. The strategy of buffering the last N channels is based on the notion that a user is likely to continue watching a channel (or one of the channels) that they have been watching in the past few minutes. Last N Channel Memory 265 (illustrated in FIG.2) provides a list of channels recently viewed by the user. This memory function may also be implemented inside controller 240. The same functionality is implemented (though not shown) in the embodiments illustrated in FIGS. 3, 4a, and 4b.

[0055] In yet another embodiment, a predictive buffering process tracks the daily and/or weekly viewing habits of the user and buffers channels and programs based on an estimate of what will be watched based on observed daily and/or weekly patterns. The predictive buffering process may also observe the particular programs that a user has

watched in the recent past (days, weeks, or months) and buffers each occurrence of this program, regardless of timeslot. In another embodiment, a predictive buffering process tracks favorite genres of the user and buffers based on a best match of recording opportunities to these favorite genres. In yet another embodiment, a predictive buffering process uses information and recommendations gathered from on-line or off-line television critics, favorite Web Logs (blogs), buddy lists, chat rooms, and other on-line recommendations, and buffers programs and channels based on a best match between a profile of the PVR user and the on-line recommendations.

[0056] FIG. 5a and FIG. 5b illustrate one possible data structure to track weekly user viewing habits. Referring to FIG. 5a, table of weekly timeslots 500 is created as an initialization step. Table of weekly timeslots 500 comprises a plurality of columns, each of which represents one day of the week, and a plurality of rows, each of which represents a timeslot within a day. The duration of each timeslot may be set to any value, but is preferentially set to the duration of the shortest typical program (1/2 hour, in the example presented in FIG. 5a). A particular entry in the table is shown in the example as 520. This is the Monday 20:00 (8:00PM) timeslot. The data structure for a typical timeslot 520 is expanded in FIG. 5b. Referring to FIG. 5b, timeslot 520 comprises zero or more entries as illustrated. Each entry in timeslot 520 contains a channel number 525 and a count 530. Count 530 indicates how many times the indicated channel has been watched. When timeslot 520 contains zero entries, this indicates that nothing was watched during the particular time slot (the PVR was always off during the time period indicated).

[0057] FIG. 6 illustrates a flow chart for an exemplary process used to populate table of weekly timeslots 500. Step 610 is the initialization step for the creation of the table. This step is performed when the PVR is first installed and powered. Once table of weekly timeslots 500 is created, the process runs continuously while the PVR is "On" (being used to watch television programs). The process monitors the current time and, when the current time indicates the start of a new timeslot (step 620), the current channel is retrieved (step 630). If the current channel is not yet in the current timeslot data structure (step 640), it is added (step 650). Otherwise, the count for the current channel in the current timeslot is incremented (step 660). In an alternate embodiment, instead of using the channel tuned to at the instant the timeslot begins, the channel watched for a majority of the time during the timeslot is used. In yet another embodiment, instead of a simple count of the number of times a channel was watched during a timeslot, the number of minutes watched for each channel within a timeslot is recorded.

[0058] FIG. 7 is a flow chart for an exemplary process to use the table of weekly timeslots 500 to perform the predictive buffering function. The process begins by waiting for an available tuner (step 705). When a tuner becomes available, the process gets the entry in the table of weekly timeslots 500 that applies to the current day and time (step 710). If there are no channels listed in this entry (step 715), no action is taken. If one or more channel entries are present, the channel entry with the highest count is selected (step 720). The tuner is set to the channel indicated (step 725), and the unit begins recording (step 730) the respective stream in buffer 252. During the predictive buffering process, if the user turns on the unit or changes channel, the predictive buffering process goes back to an idle state (waiting for an available tuner).

[0059] Once predictive buffering begins, the process in FIG. 7 waits for the start of the next timeslot (step 735). At the start of the next timeslot, if a tuner is still available (step 740), the process checks for channel entries in the table of weekly timeslots 500 at the new timeslot (step 755). If an entry is present, the channel entry with the highest count is selected (step 720), the tuner is set to the channel indicated (step 725), and the unit begins recording (step 730) the new channel. If no channel entry is present, the unit may continue recording the channel from the previous timeslot (step 760) or may stop the recording process. Note that a PVR with multiple tuners may have multiple simultaneous processes like that shown in FIG. 7.

[0060] In another embodiment, genres of programs watched are tallied for each timeslot. Genres include, for example, Sports, News, Movies, Situation Comedy, Drama, Variety, Children's Programming, etc. The most common genre for programs watched in each timeslot may be used in addition to, or in place of, the channel frequency data described above. For example, at the start of each timeslot, assuming that a tuner is available, the most watched genre for the timeslot is compared to the genres of all programs available for buffering. The program whose genre is identical to, or closest to, the most watched genre for the timeslot is buffered.

[0061] In yet another embodiment, a list of most-watched programs (regardless of timeslot) is kept by the PVR. In each timeslot, programs available for buffering are compared to the list of most-watched programs. If any programs on the list match any of the programs available for buffering, the program highest on the list that is also available is buffered.

[0062] In yet another embodiment, the PVR is connected to the Internet or to a personal computer that is connected to the Internet. Program or channel recommendations are collected by the PVR from a variety of sources. These recommendations, either alone, or in combination with other techniques mentioned herein, would be used by the PVR to make decisions on which programs or channels to buffer. One source of recommendations is from on-line television critics. One or more selected on-line television critics' recommendations may be extracted from web-sites of reviews or may be delivered directly to the PVR or personal computer using a protocol such as RSS (Rich Site Summary) or other XML or text-based protocol. Another source of recommendations is a Web Log (commonly called a "blog"). The PVR would be configured to extract program or channel recommendations from specific Web Logs. Yet another source of recommendations is an instant messaging system (and related systems such as chat rooms, IRC, etc.). Program and channel recommendations would be extracted from instant messages and chat room conversations.

[0063] In one embodiment, when a user begins to watch a program that has been buffered in buffer 252 (or 352), after the start of the program, he/she has the option to rewind to the start of the program and watch it in its entirety. In another embodiment, when the user begins to watch a program that has been buffered by the PVR, after the start of the program, the PVR detects that the user has not seen the program from the beginning and automatically rewinds to the start of the program.

[0064] Program Buffer 242 (or 352), in one embodiment, can buffer only a limited quantity of program material. This limitation may be based on the available storage space at any particular time, or it may be a fixed and reserved amount of storage

space. In either case, there is a need to flush unneeded program material from Program Buffer 242 (or 352) to allow for newer material to be buffered. When a program or a portion of a program is buffered, and the user does not indicate that he/she wants to watch the buffered program (or does not begin watching the program within some predetermined time from the start of the program), the buffered program or program portion is discarded to allow for a portion of another program to be buffered.

[0065] In most cases, the predictive buffering algorithms described above will work quite effectively, even in households with multiple viewers having different viewing preferences. This is based on the observation that the typical household television is used in a repeated and predictable manner, and that the programs viewed in each timeslot are likewise predictable. In some situations, this may not provide sufficient prediction accuracy. In one embodiment, the PVR includes the capability to detect which viewer within a household is watching in each time slot (for example, User Identification 260), and builds preference tables for each detected viewer. Detecting who is watching may be accomplished by using one or more of following strategies:

[0066] - Associating a user with what channel is being watched.

[0067] - Inferring from how the remote control is used in response to changes in the program being watched (for example, how much channel surfing does the user do, how quickly does a user switch away from commercials and how does the user set and modify the volume control and mute control).

[0068] - Creating a dexterity profile by measuring generic parameters during the use of the remote control, including: timing, pressure, and duration of button presses (create unique viewer signatures).

[0069] - Requesting or requiring that each user log in when he/she begins watching programs from the PVR. The PVR would be provided with a list of users during the set-up and initialization process. If a new user logs in, this user would be added to the user list.

[0070] - Using one or more biometric recognition/identification technologies (fingerprint, iris, palm, voice, or face, for example) to identify the user or users currently watching.

[0071] – Using a unique wireless tag contained within or attached to the body, clothing, or jewelry of, or embedded within any device (cell phone or PDA, for example), associated with (for example, carried by), each of the users. The tag may be implemented as a proprietary or industry standard Radio Frequency Identification (RFID) tag, an infrared identifier, an ultrasonic identifier, or any other equivalent means that provides wireless identification.

[0072] The many features and advantages of the invention are apparent from the detailed specification. Thus, the appended claims are intended to cover all such features and advantages of the invention that fall within the true spirit and scope of the invention. Further, since numerous modifications and variations will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation illustrated and described. Accordingly, all appropriate modifications and equivalents may be included within the scope of the invention.

[0073] While the invention has been described in conjunction with a video signal, it is also applicable to the recording of radio programming, or any other broadcast or communicated media stream.

[0074] Although this invention has been illustrated by reference to specific embodiments, it will be apparent to those skilled in the art that various changes and modifications may be made which clearly fall within the scope of the invention. The invention is intended to be protected broadly within the spirit and scope of the appended claims.